

# The Oldest Organ in Christendom

## Bethlehem Organ of Latin Kingdom Date<sup>1</sup>

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In 1906, construction workers digging near the Church of the Nativity in Bethlehem found a large number of organ pipes and some bells. The shapes of both bells, of early 'beehive' shape (fig. 1), and pipes leaves little doubt that both date back to the Latin Kingdom of Jerusalem of the eleventh and early twelfth centuries.<sup>2</sup> If this is so, then these pipes are, by several centuries, the oldest that we have except for the very small pipes of the Roman organ from Aquincum, the Roman suburb of Budapest.<sup>3</sup> There has always been a tradition that the bells of the Basilica of the Annunciation had been buried after their use had been prohibited in the 15th century, and it seems probable that the same had happened to these pipes, either when the Latin Kingdom was overrun by its Saracen conquerors or when strict Muslim prohibitions against church music had come into force. The pipes are now in the Studium Biblicum Franciscanum Museum in the Convent of the Flagellation in the Via Dolorosa of the Old City of Jerusalem, and I must record my gratitude to the Curator, Father Michel Piccirillo, for permitting me the privilege of examining, measuring and photographing a number of them in 1984.

There are, today, displayed in the Museum (fig. 1), just under 220 pipes. According to the early reports 251 were found, and this number presumably includes

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<sup>1</sup> I would record my gratitude to the late Dr Bathya Bayer (*z.l.*), who introduced me to this organ.

<sup>2</sup> Some of the bells are illustrated in both André Lehr, *The Art of the Carillon in the Low Countries* (Tiel: Lannoo, 1991), 79–80 and figs. 104 and 129, and Percival Price, *Bells & Man* (Oxford: Oxford University Press, 1983), p.96. Lehr firmly classes the surviving bells into two chimes, one of four notes from nominal C to G and the other of seven, from C to B.

<sup>3</sup> Melinda Kaba, *Die Römische Orgel von Aquincum (3. Jahrhundert): Musicological Hungarica 6*, Budapest: Akadémia Hungarica, 1976.



Figure 1: Organ as displayed

the fragments of broken pipes in a cupboard underneath the display, though some were originally said to have been discarded. There is no trace of anything but pipes – no woodwork nor any other metal work has survived, nor so far can any report be found that might indicate whether any such were dug up at the same time. The pipes are displayed in the Museum in an inverted V, in five ranks, so close together that only the first rank is accessible. There are 49 pipes in the first (front) rank, 42 in each of the second, third and fourth, and 43 in the fifth. In addition there is at least one pipe, and perhaps more, lying between the ranks on the boards that hold them in position.

Of the pipes in the front rank, the shortest speaking length (lip to top) is 16.8 cm and the longest is 58.8 cm. The longest pipe in the second rank is two or three centimetres longer; the central pipes in the further ranks may be longer still, but because one cannot reach the mouths since the other pipes are set so close together in front them, nor see whether the boards on which they are mounted



Figure 2: Row of mouths

are at the same level as the front rank or are stepped up, one cannot tell whether this is so. If the longest pipe indeed has a speaking length of around 60 cm, it is possible that we have an organ with 2-foot C, or perhaps B as on some other early keyboards, as the lowest note (but see below on this). However, there is no way of telling whether we have all the organ pipes that originally existed or whether there is still another hoard to be found under the ground, or whether other longer pipes were destroyed. Equally, it is possible that we have here pipes from more than one organ, perhaps used antiphonally, but since all appear to be identical in construction, if so they would seem all to be of similar date.

All the pipes, irrespective of their length, are of about the same diameter ('about' because none is in new condition; all are somewhat battered and dented), between 28 and 29 mm, and there is no scaling at all (fig. 2). This corresponds with the instructions for making pipes by Theophilus, Aribo, and the Anonymous

of Berne, all dating from the 11th century.<sup>4</sup> All the pipes were made, presumably by rolling the metal on a mandrel, with an overlap which is 3-5 mm deep (fig. 3). The pipes were made in one piece; there is no sign of a joint at the point where the conical boot joins the cylindrical body, at the base of the mouth. Although many of the fragments have broken at that point, which suggests that this may not be true, that is not surprising for this is a natural point of weakness. All the mouths are rectangular, or nearly so – some are a fraction higher at one side than at the other. If the maker was following Aribo’s advice to make the cut-up, the height of the mouth, the width of a straw, straws must then have been much thicker than they are today, for the height of the cut-up is 10 mm for most pipes, while a few are about 8 mm, and a few slightly over 10 mm. The width of the mouth is about 23 mm (fig. 4). All the pipes are cylindrical from the mouth to the top (fig. 5). The thickness of the metal varies quite considerably, from about 0.45 mm to 0.9 mm, though since this could be taken only at the open upper end of the pipe, this variation may be due to corrosion and to accidental damage. Some of the pipes still preserve their languid (‘plectrum’ in Theophilus’s terms) (fig. 4).

The metal, in the vast majority of cases, appears to be either copper or a copper alloy, for all the high spots, where the green oxide corrosion has been rubbed off in cleaning, are copper-coloured. This is true also in one case where the whole pipe appears to have been chemically cleaned. That pipe showed scraping marks, apparently original and quite deep, almost like a wood grain. ‘In the vast majority of cases’ above, because there are half a dozen pipes whose metal is white. One was accessible, and it weighed only about half as much as a copper pipe of similar size, and therefore may be presumed to be tin.<sup>5</sup> I was permitted to bring home a segment of broken pipe and that I had analysed here in Oxford. The report says:

| %Iron | %Nickel | %Copper | %Zinc | %Arsenic | %Lead | %Silver | %Tin | %Antimony |
|-------|---------|---------|-------|----------|-------|---------|------|-----------|
| <0.1  | <0.1    | 95.6    | 0.3   | <0.1     | 1.2   | 0.2     | 2.3  | 0.3       |

<sup>4</sup> These are quoted, in English, in Jean Perrot, *The Organ from its invention in the Hellenistic Period to the end of the Thirteenth Century*, translated Norma Deane (London: Oxford University Press, 1971).

<sup>5</sup> I had no scales with me and the weight was judged simply in the hand.

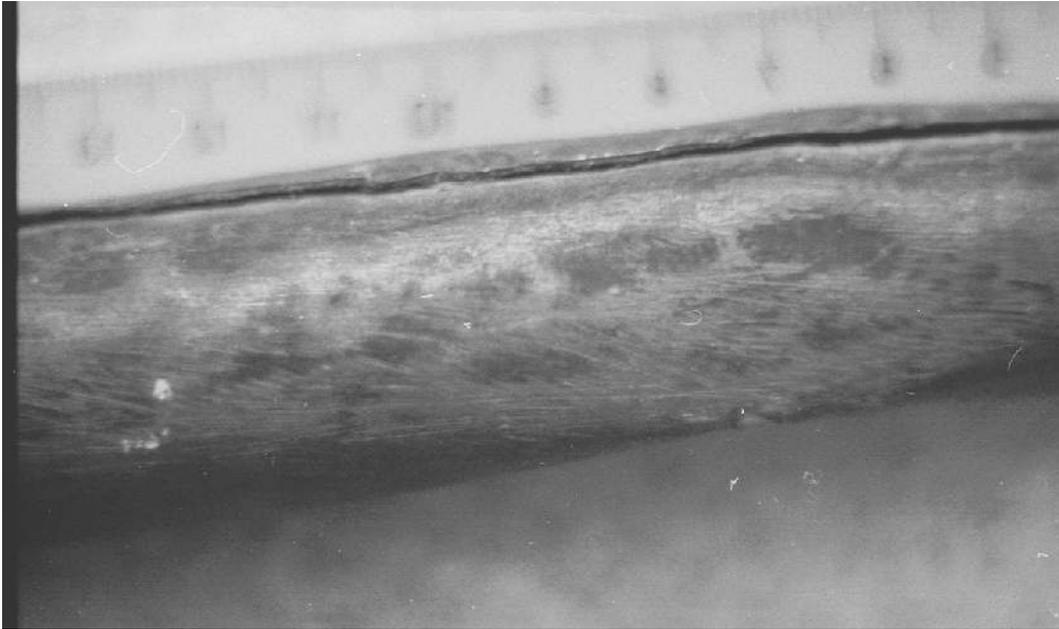


Figure 3: Pipe seam

“The organ pipe is a typical bronze (copper-tin, with traces of lead), and the dating of such things is virtually impossible.” The analyst added that there seemed to be traces of solder in the overlap.

Here we have a basic difference from the medieval instructions noted above, for both Theophilus and the Anonymous specify the use of very pure copper. To what extent ‘purity’ in those days was a relevant term is not easy to determine, but it seems unlikely that tin would have contaminated copper in its natural state, and it seems more probable that we have here a deliberate metallurgical advance in the interests of strength. The markings on that one cleaned pipe also suggest the possibility that the metal was cast in sheet form, as pipes are today, and that these markings are the grain of a wooden casting board, just as the concrete walls of buildings in the ‘Brutalist’ architectural style, such as London’s South Bank concert halls, show the marks of the wooden shuttering within which they were cast.



Figure 4: Languid



Figure 5: Cylindrical pipe with conical boot

|    |      |    |      |    |      |    |      |    |      |
|----|------|----|------|----|------|----|------|----|------|
| 1  | 16.8 | 6  | 21.3 | 3  | 23   | 16 | 24.8 | 30 | 38.9 |
|    |      | 45 | 21.4 | 10 | 23.2 | 18 | 24.8 | 21 | 39.0 |
| 2  | 17.5 | 8  | 21.5 | 13 | 23.2 | 37 | 24.8 | 19 | 39.1 |
| 49 | 17.8 | 9  | 21.5 | 44 | 23.2 | 36 | 24.8 | 22 | 39.2 |
|    |      | 46 | 21.6 | 43 | 23.2 | 35 | 24.8 |    |      |
| 7  | 20   | 11 | 21.8 | 14 | 23.3 |    |      | 28 | 44.0 |
| 48 | 20.3 | 12 | 21.8 | 42 | 23.3 | 31 | 32.1 | 26 | 44.2 |
| 47 | 20.4 |    |      | 15 | 23.4 | 17 | 32.2 | 27 | 44.2 |
| 5  | 20.4 |    |      | 41 | 23.4 | 20 | 32.3 | 23 | 44.4 |
| 4  | 20.6 |    |      | 40 | 23.4 | 33 | 32.3 | 24 | 44.4 |
|    |      |    |      | 39 | 23.5 | 34 | 32.4 |    |      |
|    |      |    |      | 38 | 23.6 | 19 | 32.4 | 25 | 58.8 |
|    |      |    |      |    |      | 32 | 34.4 |    |      |

Table 1

As noted above, only the front row of pipes was accessible for measuring. Table 1 gives the lengths, from the lip to the top. The left-hand figure in each column is the number in the row, from left to right; the right-hand figure is the length in centimetres. The pipes are grouped here in order of length, not of position in the row, because that seems to be more significant, and they are grouped here in batches of similar length. As far as could be judged by eye, the other rows were similar.

So here we have ten different pitches, with some wide gaps between them, and I presume that the other ranks fill those gaps with other pitches. When I asked if it might be possible to measure all the pipes in the other ranks, which would have meant dismantling the display, Fr. Piccirillo was horrified at the idea – they had only recently gone to great trouble to arrange them in a visually pleasing array, and he was adamant that they would not consider disturbing it. So it was

|   |  |
|---|--|
| C at 58.8   | c at 28                                |
| D at 51.9   | d at 24.5 (here at 24.8)               |
| E at 45.5   | e at 22.8 (here between 23.0 and 23.6) |
| F at 43.4 (here between 44.0 and 44.4)              | f at 21.4 (here between 21.3 and 21.8) |
| G at 38.3 (here between 38.9 and 39.2)              | g at 17.8 (here between 20.0 and 20.6) |
| A at 33.8 (here only 34.4)                          | a at 15.5 (here only at 16.8)          |
| B <sub>b</sub> at 30.9 (here between 32.1 and 32.4) | b <sub>b</sub> at 14.1                 |
| B <sub>h</sub> at 29.4                              | b <sub>h</sub> at 13.3                 |

Table 2

only possible to measure a few accessible top diameters in the other ranks, which were the same as the rest, and to see that all were all clearly made in the same way. As mentioned above, none of the mouths in the other ranks was accessible because they were behind the front-row pipes, which meant that it was impossible to measure the speaking lengths of any of those pipes.

If one divides 58.8, the length of the longest pipe in the front rank, by the formulae given by Aribo, which uses a correction factor based on fractions of the diameter of the pipe, the results produce figures different from most of our lengths, and therefore it seems unlikely that this was originally the longest pipe. The Aribo figures for two octaves, for convenience taking our longest pipe of 58.8 cm as C, and giving our nearest lengths for comparison, are given in Table 2.

These Aribo figures and Bethlehem lengths are too far apart for any practicable scale, but a better mathematician than I might be able to produce at least a theoretical probable lowest length and thus to bring them into coherence. The grouping of lengths that we have makes it very clear that the organ must have been a form of Blockwerk, something like the tenth-century organ at Winchester, described in the well-known poem by Wulstan, where ten pipes stood to each key.<sup>6</sup> Theophilus's keys (all push-and pull 'lignae', of course, not the sprung up-

<sup>6</sup> Also quoted by Perrot, p. 230.

and-down keys of later organs), each carried three pipes, perhaps two unisons and an octave, and Aribo's two. A Hebrew source, translated from Latin by Yehuda ben Yitzhak, with some Old-High-German glosses, which Hanoah Avenary suggests may be 11th century, specifies the use of octaves, fifth, fourths, and double octaves.<sup>7</sup> After giving tuning instructions for eight pipes (the lengths for which fit our pipes differently but no better than Aribo) it says: "Behind each of them set up (a tympan) in the height of the fifth tympan after it. And who has no fifth, sets up behind it (a tympan) smaller in proportions and also (smaller than) the others. Behind these set up (additional tympan), each of them being half as large as its fundamental with regard to size, length, and breadth. And according to the size of the instrument, put on every tympanist many tympan, fourths, fifths, and eighths." Avenary's 'tympan' is his translation of the original tuppim, Hebrew for drum, which one of the fore-mentioned glosses equates with orgela. It is this gloss which gives the clue for the date, for, as Avenary states, Old-High-German, which substitutes an 'l' for Latin 'n', producing orgela instead of organa, fell out of use by 1100. Note that the instruction for the octave pipes ("each of them being half as large as its fundamental with regard to size, length, and breadth") suggests that there was some scaling of diameter involved, whereas all our Bethlehem pipes are the same diameter.

Such multiplication of pipes to one key was therefore well-established by the time our pipes are likely to have been made, and thus some of our 23 cm pipes would have been unisons, some fifths, some octaves, etc of whichever key they stood to. And it also seems clear, from the difference between 23.0 and 23.6 cm, and other lengths within groups save for those at 24.8 cm, that there was a built-in tremolo.

There seem to be no contemporary references to the use of an organ in the Basilica of the Nativity. My late wife went through many pilgrim reports from

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<sup>7</sup> Hanoah Avenary, 'The Mixture Principle in the Medieval Organ', *Musical Disciplina* 4, 1950, 51–5, discussing Paris BN Fonds Hébreu 1037, 15th century with a) an Hebrew translation of a musical treatise by Abu'l-Salt (1067–1151), and b) a treatise in five chapters, translated from Latin by Yehudah ben Yitzhaq, reflecting the theory of music in the first half of the 12th century. An added 6th chapter called 'Gate on the construction of musical instruments', treating the monochord, organ pipes, and cymbala., f 27r has mensuration of organ pipes. Avenary's article includes a plate of this folio, but it is too faintly printed to read.

this period, and nowhere was there any mention of an organ, so we know nothing of its use, whether it was used liturgically within the church, or whether, as is now thought about Winchester, it might have been a signal instrument, more important for its audibility outside in the town of Bethlehem, than for musical purposes within the church.

As we said above, if the longest pipe here were the longest original pipe, then the lowest note would have been, in modern pitch, around the 2-foot C, and if the shortest here were again the original shortest, then the highest note would have been the a an octave and a sixth higher, giving just under two octaves in range. The fact that we have failed to produce a coherent pitch table by any recognised system of the period,<sup>8</sup> shows that there must have been at least some longer pipes, and possibly some shorter. However, the number of pipes we have here, up to 250, renders so small a compass improbable. With both B flat and B natural and an upper octave c', we would have 20 notes on the 'keyboard'. This would then imply twelve or more pipes standing to each key, which cannot have been likely, for this is a higher figure even than that given for Winchester. Therefore, either we have here the pipes of more than one organ, or we have a great many pipes missing from a four-foot or even larger original assembly. One further puzzle is that we have one group of five pipes without built-in beats, those at 24.8 cm (and perhaps more at that or other pitches in the ranks that could not be measured). Those at 24.8 cm cannot be an octave of the lowest pipe because we have several longer than that would be. Might it have been a twelfth? Since the fifth is the most important interval in the Pythagorean temperament, might they have wanted that to be pure? But then, other groups that we have, that could also be fifths or twelfths, are not of the same uniformity. But if these and the 24.8 cm pipes were a twelfth, can we surmise twelfths as well as octaves and fifths, even perhaps fifteenths, standing to each 'key'? If so, this would account for at least some of our excessive number of surviving pipes and reduce the number which must be missing.

Much of the above has been speculation. The problem with dealing with any remnants of the past, especially those that survive as chance finds rather than as a

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<sup>8</sup> I had also tried two other systems cited by Perrot.

result of systematic archaeology, is that we know what we have, but that we can never know what we do not have. The one thing that remains certain is that we do have at least some of an organ that bears out, in almost all details, the prescriptions that have come down to us from the tenth and eleventh centuries of how organ pipes should be constructed.

The basis of this paper was written as a FoMRHI Comm (35, April 1984, Comm. 534) almost immediately after seeing the pipes, revised with additions in 2005, and then greatly expanded as an article in a Festschrift for Jeannine Lambrechts Douillez's 80th birthday in February 2008.

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